

# ApproxASP — A Scalable Approximate Answer Set Counter

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## MOTIVATION

- **Applications:** Wide-range of applications in probabilistic inference, network reliability, planning, navigation etc.
- Existing system enumerates answer sets, thus fails to scale on instances having a large number of answer sets, and approximation suffices for large number of answer sets.

## PRELIMINARIES

**Notations:** tolerance  $\epsilon$ , confidence  $\delta$ ,  $AS(P)$  answer sets of instance  $P$ , estimate  $cnt$

### Approximate Counting:

$$\Pr \left[ \frac{|AS(P)|}{(1 + \epsilon)} \leq cnt \leq (1 + \epsilon) \cdot |AS(P)| \right] \geq 1 - \delta.$$

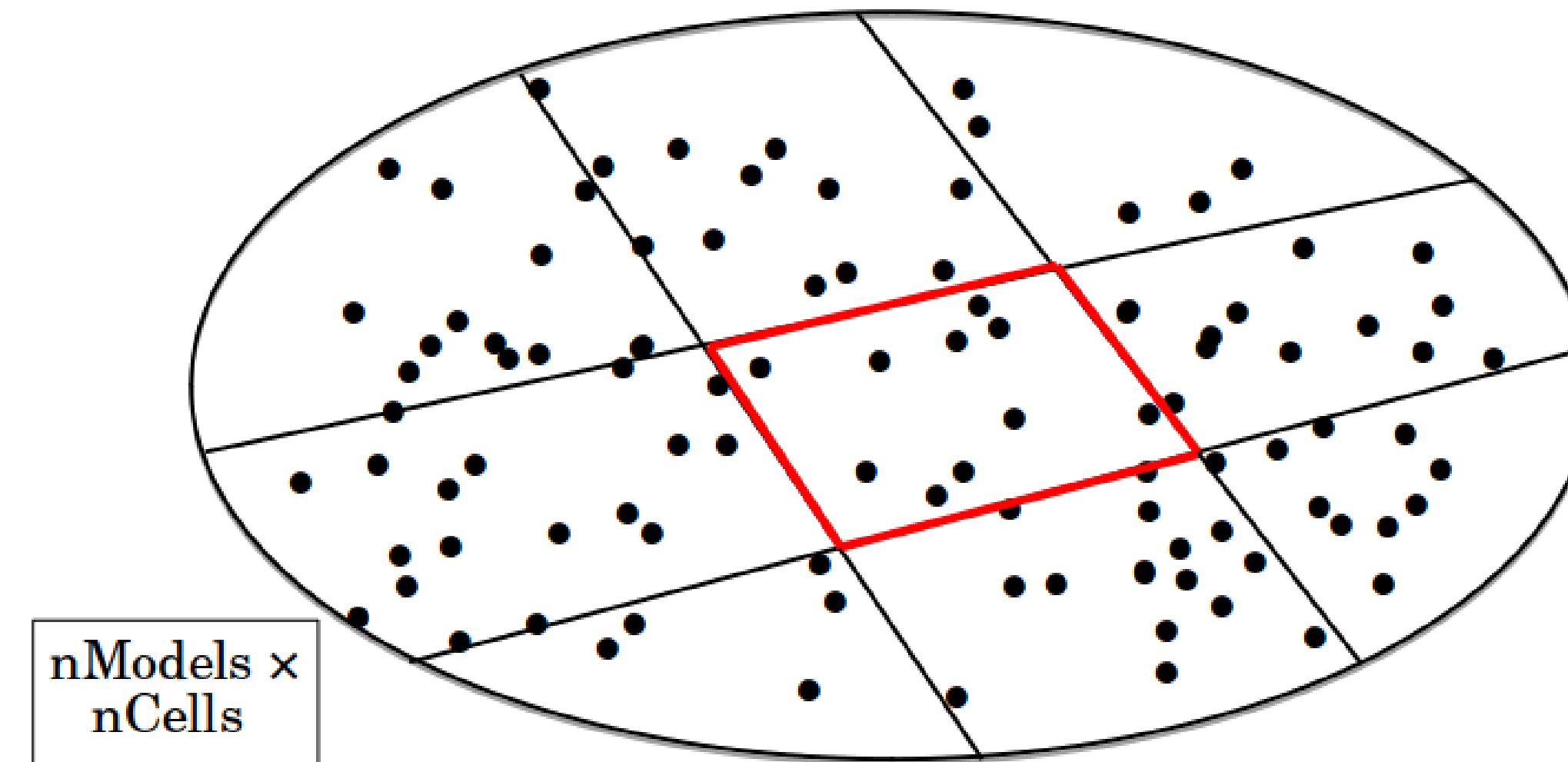
## CONTRIBUTION

- **Implementation:** tight integration of Answer Set solver and Gauss Jordan elimination
  - an efficient ASP+XOR solver
  - a scalable approximate answer set counter.
- **Correctness:** rigorous theoretic guarantee.
- **Optimization:** heuristics to achieve speed up .

## SOURCE CODE



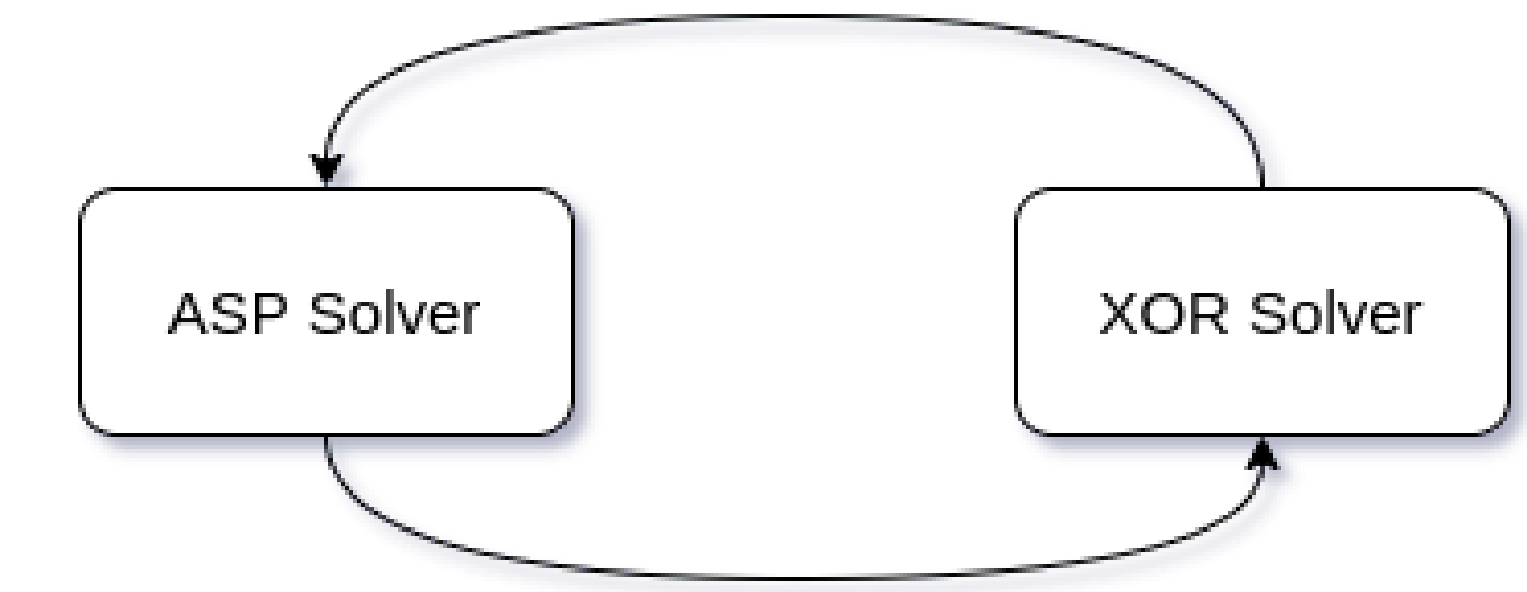
## APPROXIMATE COUNTING (ALGORITHM)



Approximate Counting Idea

- **Partition Technique:** Random XOR constraints (2-wise independent hash function).
- **Proof of Correctness:** Let  $P$  be a program and  $X$  a set of parity constraints. Then,  $AS(P \cup X) \subseteq AS(P)$ .

## IMPLEMENTATION



- **ASP Solver:** Clingo
- **XOR Solver:** Han-Jiang's Gauss Jordan Elimination

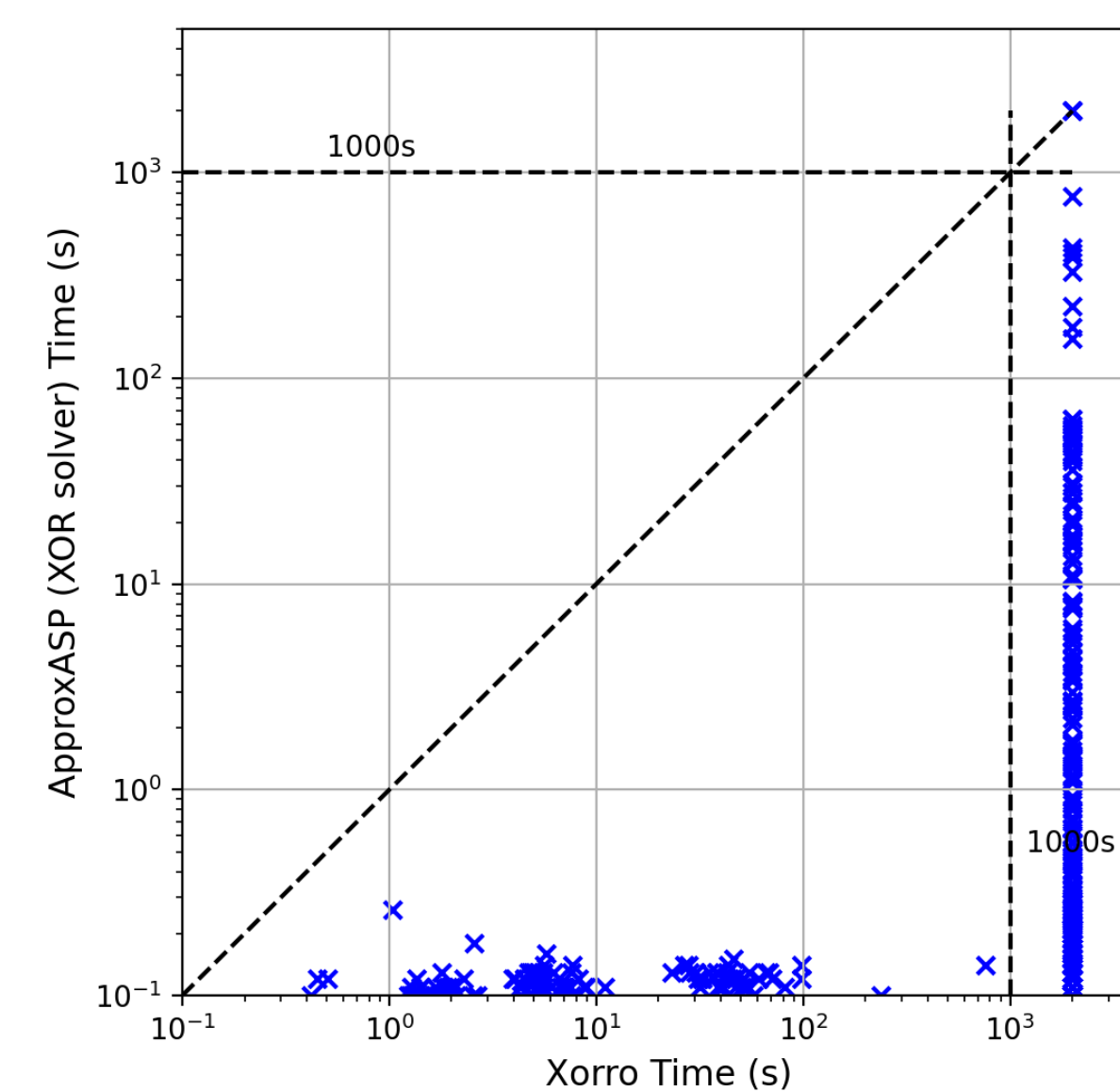
## HEURISTICS

- **Heuristic 1:** If the XOR is *satisfied*, the XOR will be satisfied as long as the ASP solver does not backtrack.
- **Heuristic 2:** If both *basic* and *non-basic* variables of an XOR are unassigned, then the state of the XOR is *undetermined*.
- **Heuristic 3:** Constructing XOR constraints from *independent support*.

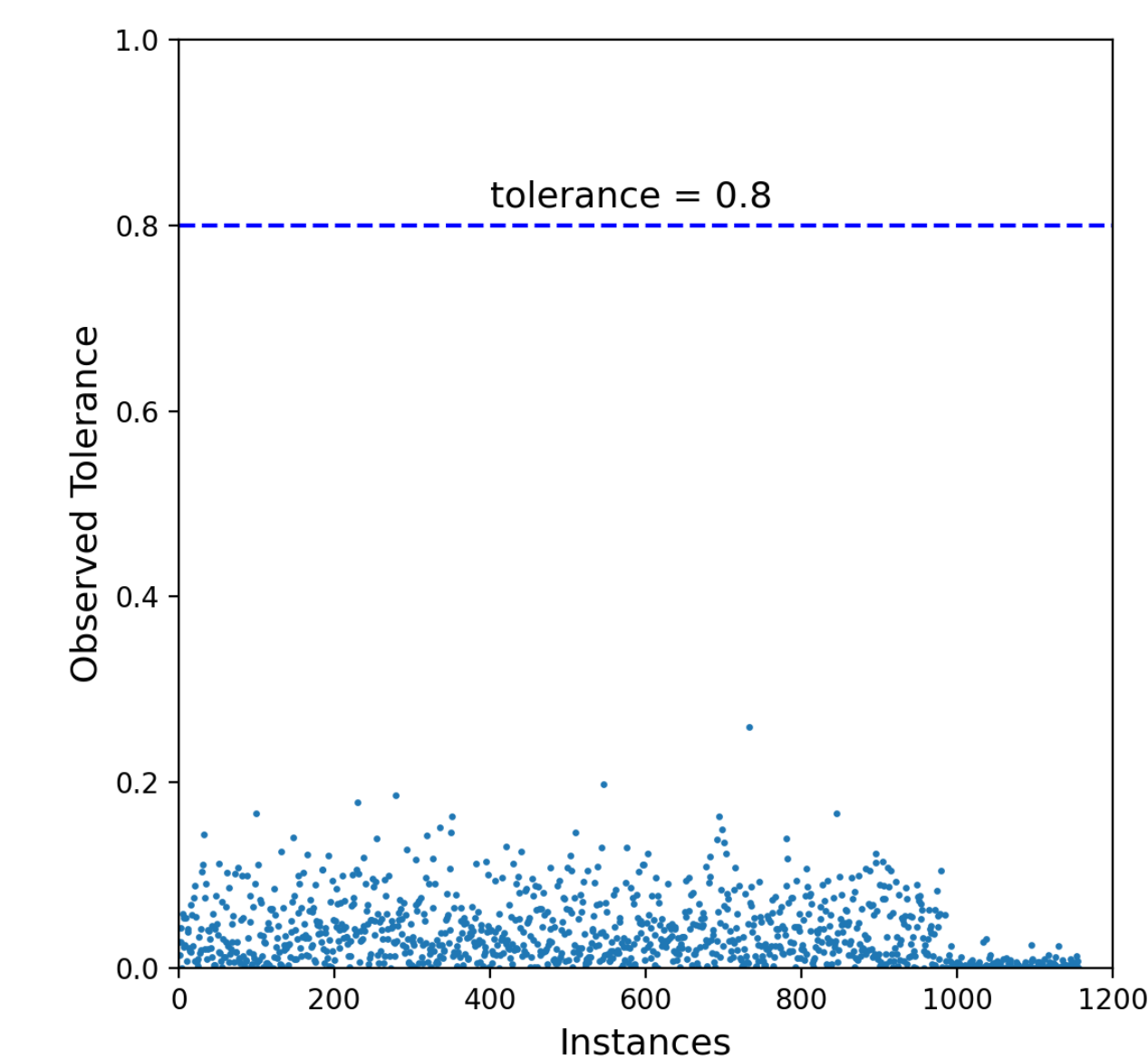
## EXPERIMENTAL RESULTS

		Clingo	DynASP	Ganak	ApproxMC	ApproxASP
Normal	#Solved	738	47	973	<b>1325</b>	1323
	PAR-2	5172	9705	3606	<b>1200</b>	1218
Disjun.	#Solved	177	0	0	0	<b>185</b>
	PAR-2	1372	10000	10000	10000	<b>795</b>

The runtime performance comparison of Clingo, DynASP, Ganak, ApproxMC, and ApproxASP on all considered instances.



The runtime comparison of ApproxASP XOR solver and Xorro



Visualization of the guaranteed count interval, which is compared with the returned counts of ApproxASP.